A CASE OF COLORED GUSTATION

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Cases of colored gustation have been described in less detail than the more common instances of colored audition. The relative infrequency with which colored tastes and colored odors have been reported has been explained from the fact that taste and odor are so bound up with the perception of a colored body that one's attention is attracted away from the photism even when it is attracted to the color of the object. The photisms are said to be most readily perceived in cases where an odor or a taste from an unknown source suddenly attracts the attention. In the present instance there has been no difficulty in perceiving the taste-color, because the latter is very brilliant, and it frequently persists more than ten minutes. Moreover, the taste-color is quite as intensive and quite as fully saturated as are the colors of objects; it can therefore be maintained without difficulty in the presence of the latter.

The young man (*S.*), who reports the present case, is a senior in college, has had some practice in psychological experimentation, and is an excellent observer. He has been under observation a year. So far as he can remember, he has always experienced tastes as colored. He reports that, as children, he and his sister employed color-names in describing their tastes. His taste-colors are located in the mouth; and they are intensified by closing his eyes. He recalls an illness during which his tastes were especially highly colored. In eating his meals, he ignores the induced colors; and, indeed, one color is frequently cancelled by another, during the act of eating. When the induced taste-color does not correspond with the actual color of the food, a most disagreeable experience results. For instance, brown and yellow mints are extremely distasteful, because of conflict of these colors with the green taste-color which is common to all mints. In general, pink and lavender tastes are agreeable; reds and browns are disagreeable. Blue tastes are never experienced. *S.* reports that colors suggest tactual experiences, and that tactual impressions suggest color.

In our investigation of the case, the following questions were kept in mind throughout: 1. Does *S.* possess a normal

sensitivity to taste? 2. Are the color-tones of his tastes uniformly determined by any particular factor in the gustatory complex? 3. Is the induced color sensational or imaginal? 4. Are his associations of touch and color comparable with his associations of taste and color? 5. Is there a correspondence between the feeling-tone of taste and that of its attendant color?

1. Does our Subject Possess a Normal Gustatory Sensitivity?

In our determination of the limens both for the presence and for the recognition of taste sensation, the method employed by Miss Thompson[1] was followed precisely, in order that our results might be comparable with hers. *S.*'s limens of presence were as follows,—all solutions being prepared with distilled water, and each limen being regarded as established only when three out of four judgments were correct: Sweet, .0005 per cent. saccharin; salt, .04 per cent. pure sodium chloride; sour, .003 per cent. sulphuric acid; bitter, .00008 per cent. sulphate of quinine. A reference to Miss Thompson's curves shows that five of her twenty-five male subjects gave a limen for sweet as low as that of the present subject; four of her subjects gave a limen for salt as low as *S.*, and two subjects a lower limen. Seven gave the same limen for sour, and four subjects gave a lower limen. Miss Thompson reports no subject whose limen for the presence of bitter was as low as that obtained for *S.*

In our investigation of the limens of recognition it was found that *S.* showed great facility in describing the tactual accompaniments of the four taste qualities. His judgments of the taste qualities were usually indirect inferences which were based upon the local tactual or color accompaniments. He described salt, sweet, sour and bitter as merely 'feels' upon the tongue. He insisted that a lump of sugar had no taste; and he remarked casually that rock-candy was salt. None the less, his gustatory sensitivity appeared normal, or supranormal.

The limen for the recognition of sweet was .0005 per cent. saccharin,—a lower limen than Miss Thompson obtained for any of her male subjects. Discrimination both of this taste quality and of its relative intensity was due to the presence of the concomitant black, which was present even with the weakest solution which we employed. The 'feel' of sweet was usually located at the tip of the tongue.

[1] H. B. Thompson: *Psychological Norms in Men and Women.* University of Chicago Contributions to Philosophy, IV. 1. 1903, 50 f.

The limen for the recognition of salt was about average,—.11 per cent. sodium chloride. Four of Miss Thompson's subjects gave the same, and ten gave a lower limen. Color rarely appeared with this solution; when it did appear it was slate or dirty white. The discrimination of salt from sweet revealed the following characteristics: It was differently localized; it failed to persist; it had no color. The judgments were given slowly, and with clear consciousness of the foundation upon which they were based.

The limen for recognition of sour was also average, or somewhat high,—.007 per cent. sulphuric acid, a limen which Miss Thompson found for twelve of her subjects, while seven of her subjects gave a lower limen. Color entered the experience, but without much uniformity,—brown, red and green being reported. The distinctive tactual component was its puckering character.

The limen for recognition of bitter was low. At the point where discrimination began,—.0003 per cent. sulphate of quinine,—a dull orange-red entered the experience, and became more pronounced as the solutions increased in intensity. The tactual component was a roughness. *S.* remarked that the solution tasted exactly like a mixture of red pepper and water. Only one of Miss Thompson's male subjects gave the same limen as *S.*, and only two gave a lower limen. It seems to be significant that the two solutions which gave the lowest limens for recognition,—the sweet and the bitter,—are just those taste qualities which are most unambiguously colored.

Individual papillæ were stimulated by means of strong solutions of the four sapid substances, and it was found that the color component did not occur with minutely circumscribed stimulation. Here as before, discrimination proved to be a product of tactual differentiæ, excepting in the case of bitter. The rough effect which was noticeable in the case of bitter with extensive stimulation was lacking in the papillary test. *S.* identified bitter by successively eliminating the other three taste qualities. He also reported an intermittence or 'beating' of sensation, which facilitated his identification; the identification was made very slowly but with considerable accuracy. When, on withdrawing the tongue, the solution spread over the lingual surface, the familiar orange-red appeared. In not a single instance did *S.* detect the purely bitter quality of the solution,—a two per cent. solution of hydrochlorate of quinine.

Although our tests suggest the inference that *S.*'s sense of taste may be defective, they do no more than suggest it. A crucial test would involve a separation of tactual and gustatory

qualities,—a separation which, indeed, we attempted but without success.

The most convincing evidence of a defective gustatory sensitivity is furnished by *S.*'s insistence that solutions of cayenne pepper and of quinine taste exactly alike. He was, indeed, unable to distinguish between strong solutions of red pepper and of quinine, because both produced the same 'feel' upon the tongue, and both were accompanied by the same color. After rubbing his forehead with capsicum vaseline, *S.* reported a 'smart' or 'burn,' which, although not accompanied by color, gave 'the same tactual feeling as the taste of bitter.' It would seem that, for *S.*, bitter is simply a rough, burning sensation. He does not find the taste of quinine unduly disagreeable; and he shows none of the ordinary reactions to an intensive bitter. He is, moreover, unable to understand how bitter, as he employs the term, is, in the slightest degree, characteristic of the taste of unsweetened chocolate or of ground coffee, both of which gave the color brown. All spices, on the other hand, induced red or reddish brown colors, similar to the color of pepper. His recognition of spices was slow. Cinnamon and mustard were named, but without any high degree of confidence; and ginger was stated to be either cinnamon or pepper. It is a significant fact that the taste of bitter, which furnished the best evidence of a gustatory defect, was also the taste which was most uniformly and most unambiguously accompanied by color.

As already stated, *S.* describes sugar as a 'feel.' He sugars his food in order to make the taste milder; and he is accustomed to put a pinch of salt into chocolate in order to change its 'feel'. When a drop of peppermint, or of lemon juice was added to salt, *S.* identified the salt very slowly, and even confused it with sugar.

His recognition of tastes was often retarded to a remarkable degree. In one instance, strong essence of peppermint was not identified until after three minutes. In repeated experiments with anise, which is attended by a brilliant black color, it was found that this color appeared in time to serve as a mark of identification. Sarsaparilla syrup, which likewise induced black, was also identified as anise. Listerine was at first called camphor and alum; and, after four tests in which its name was furnished to *S.*, he still failed to recognize it.

The question naturally arises as to whether *S.*'s olfactory sense is normal. A test with the olfactometer showed that it is. It is possible that the recognition of strongly odoriferous substances was, at times, retarded by the brilliant taste-colors,

which may have served to distract attention. It was found, however, that odors are not colored for *S.* save in rare instances. In the few positive cases which we discovered during the course of the investigation, a distinct taste was found to be induced by the olfactory stimulation.

2. Is the Color-tone of Tastes Uniformly Determined by any Particular Component in the Gustatory Complex?

Here the writer recognized the possibility that odor was the factor which determined the color-tone of the taste; and this possibility was carefully tested. Solutions including syrups of orange, lemon, cherry, pineapple, the essences of wintergreen, anise, and bitter almonds together with lime-juice and alum were employed. *S.* plugged his nostrils and the central region of the tongue was painted lightly with the solution, *S.* immediately recording his experience without withdrawing his tongue. The sides and tip of the lingual surface were then painted, and records were made as before. Then a few drops of the solution were placed upon the tongue and allowed to spread, and to be swallowed. And finally the nostrils were unplugged, and a few drops of the solution were taken and immediately swallowed. The results of these experiments were clear-cut and definite. Excepting in the case of the intensely sweet solutions, color entered the complex only when the solution spread over the surface of the tongue. This color became more intensive and more persistent when, on the nostrils being unplugged, the olfactory component was added to the gustatory complex.

The author was tempted to conclude that the presence of color in the complex was largely due to the olfactory component. But this conclusion is not in accord with the fact that odorless tastes,—those from our sweet, sour and bitter solutions aroused colors; and with the additional fact that odors themselves were uncolored, save in rare instances. On the other hand, the fact that the taste-colors were frequently intensified by unplugging the nostrils, and the fact that intensive colors were more frequently present when the substances were more strongly flavored, suggest the influence of odor as an inducer of color. The presence of odor and of extensive stimulation certainly increases the vividness and the persistence of the taste-colors.

The writer is convinced that a thoroughgoing analysis would reveal the existence of a constant and uniform principle which determines the color tones of various tastes. It must be confessed, however, that certain facts still remain unaccounted for, even after extensive experimentation. A cata-

logue of the colors which are induced by various stimulations shows that it is impossible to classify them upon the basis of the olfactory component; it is possible, however, to a certain extent, to classify them upon the basis of the four taste qualities. It must be borne in mind that, for *S.*, the chief characteristic of a taste is frequently its tactual, and particularly its pungent or cooling effect. And this peculiarity must be reckoned with in any attempted classification of tastes. But so distinct are the complexes experienced that any endeavor to classify the very individual gustatory fusions under four heads must appear to be forced. With these reservations in mind, however, we shall attempt the classification.

Strong solutions of sugar and weak solutions of saccharin were found to give black, although, strangely enough, neither granulated nor lump sugar gave a colored taste. The latter, in fact, were not found to be intensively sweet, although they produced a distinct tactual sensation. Anise, cherry syrup and sarsaparilla syrup were described as sweet, and induced black,—that of anise being very brilliant. Tar-water also gave a black taste; but *S.* was uncertain whether, in this case, he actually experienced a true synæsthesia. The induced black seemed to him to be imaginal rather than sensational.

Quinine solutions, both strong and weak, gave a dull orange-red taste,—an orange-red which re-appeared in the taste of red-pepper, essence of bitter almonds, and alum. A modified red was induced by lime juice, peach flavor, pineapple syrup, and various spices. As previously mentioned, the burn or sting of the sensation was a prominent part of such tastes.

Saturated salt solution was found to give a crystal-clear experience. Moreover, it was found that a salt solution would remove mouth-colors which were already present,—a discovery which proved to be most valuable in experimentation, since the long persistence of the taste-colors made experimentation an exceedingly slow and laborious process. Listerine was the only other solution found to have this effect.

The results obtained from sour were less clear-cut than those from other taste-qualities. Green is, perhaps, the color of purely sour solutions. An occasional flash of green appeared in the test with minimal solutions. Eight per cent. tartaric acid was used as a strong solution, and this also gave, at times, a flash of green. It was noticeable that even this strong sour solution was sometimes confused with bitter. An attempt was made to provide tastes that *S.* would find very sour. This proved to be difficult. A lemon juice that the experi-

menter found excessively sour seemed to *S.* to be only moderately so. This lemon juice was found to give, however, a flash of green, a green which was more certainly induced when the lemon juice was *cooled.* A sour, lemon-pineapple sherbet was reported as very green, a green which persisted. In the laboratory tests, peppermint was the only solution that gave uniformly a persistent and vivid green. It would seem from these facts that a cooling-effect is essential to green tastes. It is, moreover, not without interest that *S.* classifies peppermint as a sour taste.

Usually, in the tests in which green appeared, it was very unstable, alternating with the color pink or red. Such alternation was observed for orange syrup, peach syrup and, above all, for wintergreen. Wintergreen, in fact, gave the most interesting results. The taste-color of wintergreen was a brilliant pink, which, however, was preceded by green or alternated with green. Usually the green persisted only a few seconds, while the pink lasted many minutes. When, however, the wintergreen solution was *cooled,* it gave a green that persisted nearly two minutes before changing to pink, while the same solution when warmed, gave a deeper pink than usual, and no green.

The alternation of green with pink raises an interesting question, as to the possibility of obtaining after-image effects from colored tastes. In support of the affirmative answer to this question, are two other casual observations. Once a black taste became white; and *S.* reported a grape-juice punch that in course of eating changed from a purple to a yellow taste. On the other hand, on this assumption, it is difficult to understand why the vivid green of peppermint, which at times persisted many minutes, should fail to give an after-image. In any case, we are left with pink as an unexplained color.

Tests of the effect of mixing the standard solutions, and the effect of successive applications of such solutions, were next planned. The mixed solutions gave the following results: Salt and sweet produced a sweet taste without color; salt and tartaric acid tasted salt and bitter and induced dark orange; salt and quinine gave a bitter taste and a faint suggestion of red; tartaric acid and sweet gave, upon one occasion, a sour-sweet taste, and a pink color; a second time, a sour taste with a flash of green; tartaric acid and quinine produced a bitter taste and a reddish color, which was less pronounced than usual; quinine and sugar solution tasted sweet, although the combination was very bitter for the experimenter, and produced a "queer hollow black" which vanished as soon as the solution was swallowed.

Application of the standard solutions in pairs was next attempted, each pair being utilized twice, and the order of application varied. The results, on the application of the second solution, were as follows: Salt-sweet, no taste, no color; sweet-salt, no taste, no color; salt-tartaric acid, biting effect of salt intensified, no color; tartaric acid-salt, salty taste, no color; salt-quinine, neutralized taste, red color as soon as salt effect wears off; quinine-salt, second taste clears up the first, then orange-red returns; tartaric acid-sweet, neutral taste, no color; sweet-tartaric acid, sweet then sour taste, green with sour taste; tartaric acid—quinine, taste not recorded, color red, a different red from that produced by pure taste of bitter; quinine-tartaric acid, taste not recorded, orange-red of bitter taste brightened by sour stimulation; quinine-sugar, taste unrecorded, orange-red unchanged; sugar-quinine, bitter taste prevailed, red darker than bitter-red.

One seems justified in concluding that salt "clears up" the colors induced by the other solutions, but that this "clearing-up" is least stable in the case of bitter. Sour is found to modify the orange-red of bitter, and to neutralize sweet, once giving pink, in this combination; bitter and sweet appear, at times, to give a color intermediate between the colors of the pure solutions.

It seemed possible that pink represented a sour-sweet taste. Lemon juice was accordingly sweetened in the hope of producing a pink taste. One attempt was successful; but a second attempt gave yellow instead. It is very difficult to make the sweet in a mixture perceptible for *S*. Peppermint essence was dropped on sugar; but the sugar was "not even tasted" and the green taste remained unchanged. If, in fact, pink be a sour-sweet taste, the color is certainly not a mixture of the colors obtained from pure sour and a saturated sugar solution.

The pink of wintergreen unites with the golden color induced by a lime wafer, to produce a rose-color, unlike the usual pink of wintergreen. If anise be taken while the wintergreen pink is still bright, there is a change to brilliant black. This black persists for a short time only; and a dirty pink results, which, in time, clears up, and gives a light pink which lasts several minutes.

The only other color that remains unaccounted for is yellow, with its variants,—tan and brown. This color was obtained from the following solutions: sweetened lemon juice, yellow (once); peppermint on salt, yellow (tried once); vanilla, tan or brown (constant); lime juice, yellow (once, alternating with red); lime candy wafer, golden (constant); lemon candy

wafer, yellow and brown (tried once); lemon essence diluted, yellowish brown mixed with green; sassafras candy wafer, pink shot with yellow light (tried once); hot oil of cloves diluted, tannish brown (tried once); same solution on salt, flash of brown (tried once); chocolate and coffee, dark brown (constant); nuts of various kinds,—brown, minced English walnuts giving the lightest color. Once, while the green taste of peppermint was still vivid, wintergreen was given. This stimulation resulted in a bright and pronounced pink, which changed finally to tan.

It is perhaps unnecessary to state that all tests were tried without *S.*'s knowledge of the stimulus to be given and that his eyes were usually closed, during the test.

3. Is the Induced Color Sensational or Imaginal?

That the color element in the tastes under consideration was sensational in value seems to us to be proved by its constancy in tone for a given taste, as shown by tests at widely separated intervals; by its persistence; by its localization in the mouth; and by the fact that results were novel and unanticipated by *S.*, who was curious as to what might come, and reported results as in a sensation test. Several of the solutions were new to him, as, for instance, anise; but these new gustatory experiences yielded as constant colors as did the familiar tastes. It was noticeable that the color was usually named before a taste was recognized; in fact, *S.* frequently relies upon color as an aid in recognition. These taste-colors were not influenced by suggestion, as was shown by tests. Moreover, when colored candy wafers were used, and the eyes kept open, the color experienced was not affected by the objective color.

S. found difficulty in describing the taste-colors. For instance, he reported that the beautiful glazed black of anise, had never been experienced in any other connection. *S.* insisted that color is an integral part of the taste-fusion, and reported that wintergreen changed perceptibly in taste when it shifted from green to pink.

That the colors were not called up voluntarily is shown by the fact that, when asked to give from memory the color of a particular taste, *S.* frequently made mistakes, even in the case of solutions that gave perfectly uniform results during experimentation. Furthermore, *S.* showed very little capacity in voluntary visualization of colors, and was unable to project these colors.

S. also showed little capacity in the voluntary projection of a taste-color to an external surface. Twice, however, the surface upon which he was gazing became, to his surprise, a

brilliant pink, the color of the wintergreen which he was tasting. Both of these occurrences were spontaneous and unexpected. Attempts to throw the mouth-color upon a colored surface, in order to test the effect of such superposition, met with little success. In general, when instructed to gaze steadfastly at a colored surface while experiencing a taste-color, *S.* reported most disagreeable tension with dizziness. The mouth-color was fully as vivid as the objective color, but was differently localized.

The following were among the tests which we attempted. Strong essence of wintergreen was given, and pink color obtained in mouth; disc of spectral green placed before *S.*; no fusion. Attempt made to throw green peppermint taste-color upon rose paper; unsuccessful. *S.* unable to keep attention off mouth-color even when so instructed; rose finally fixated for 45 sec.; eyes then closed; *S.* got gray in front of eyes, and green in mouth; then a rose-red image came, and seemed to fuse with green; green returned. Attempt made to throw the brown obtained from cinnamon candy wafer upon dark blue paper; no fusion; intermittent attention; blue caused confusion and dizziness; blue did not banish brown which became darker. Orange-red pepper taste obtained and dark green paper used to stimulate eyes; attention fluctuates; no fusion. After-images were also obtained before giving a taste-stimulation and an attempt made to fuse these colors with those induced by taste, but without success. The eyes were fatigued for a certain color without any perceptible effect upon a mouth-color of the same general tone. Thus, fatiguing for black had apparently no effect upon the black taste of anise; and fatiguing for green had no effect upon the green peppermint taste. While maintaining green in the mouth, *S.* could get an after-image from spectral green without interference of colors. It has already been mentioned that peppermint green can be maintained as long as seven minutes, without failure of the color through fatigue.

4. Are the Associations of Touch and Color Comparable with the Associations of Taste and Color?

Our experimental results lead us to answer this question in the negative. Color calls up tactual experiences much more consistently and much more frequently than touch evokes color. In an investigation of the latter situation, it was found that certain tactual experiences frequently suggested color, but that these colors were only rarely sensational in value, and were not uniform in tone. Occasionally there were instances of true synæsthesia; but there was no evidence of

a systematic case. On the other hand, colors do, apparently, call up true tactual sensations. *S.* named the "tactual feel" of every color in the Bradley chart of spectrum scales,—a test which left his hand itching and in a disagreeable condition. Nevertheless, it is very difficult to determine in how far these tactual experiences were anything more than the usual secondary accompaniment to visual perception. With his eyes closed, *S.* was frequently unable to confirm, by stroking the material, the tactual impression which he received from the visual stimulation. On the whole, however, it was evident that *S.* obtained unusually acute suggestions of tactual texture from visual texture. It is obvious that a satisfactory explanation of synæsthesia must await a more complete understanding of the secondary element in perception. In the meanwhile, border-line cases deserve more careful examination than they have received.

It is not without interest that *S.*'s preferred form of attention is auditory. He is very musical, and has an excellent command of auditory imagery. Colored audition seems to him to be forced and extraordinary. Yet, during a recent test, on the imagery aroused by poetic fragments, he has twice reported changing an auditory suggestion into a play of imaginal colors.

5. Is there a Correspondence Between the Feeling Tone of each Taste and the Feeling Tone of its Induced Color?

It has been suggested that synæsthetic experiences involve associations through emotional similarity. The suggestion has, perhaps, been couched in too general terms to deserve detailed consideration. Our conclusion, after a careful observation of *S.* for a year, is that his experiences of taste-color are, on the whole, indifferent to him, and that there has been no æsthetic organization of tastes on a color basis, as has been suggested to be a possibility in such cases. Violets and blues, which were found by the method of paired comparison to be *S.*'s preferred colors, play no part in these experiences. The judgment 'agreeable' or 'disagreeable' is, apparently, given on the basis of the whole gustatory experience of which color constitutes an essential part. In at least one case, however, the taste of lime candy, *S.* spoke of the color, golden, as being very "pretty," while the taste was not "particularly agreeable." There was frequent disagreement between the affective tone of the color and of its tactual accompaniment. Thus, green has an agreeable "feel," but is not an agreeable color. Violet-blues are agreeable in color, but not particularly so in

"feel." Blue-greens give a "perfectly awful feeling, like running the hand over sand-paper; disagreeable to both sight and touch." The double arousal of sense-qualities, in the manner under discussion, is not without interest in the investigation of feeling-tone. It would seem to afford an especially good opportunity for the investigation of mixed feelings. Our observations on this latter point were too meagre to lead to any definite conclusion, except the unlikelihood of the synæsthetic experiences, in the present case, being explicable upon an affective basis.

In conclusion, the following facts, as deduced from the present study, are important in a theoretical consideration of synæsthesia:

1. The synæsthetic factor is sensational in value, as has been demonstrated in many other cases.

2. The color hallucination may be induced by the minimal sensory intensity of the primary component of the gustatory fusion. Other reported cases have also shown sensory defects of the primary sense-organ. Thus Pierce reports defective hearing in connection with gustatory audition. On the other hand, the literature of the subject frequently states that, in particular instances, no sensory defects were found. The reliance, in the majority of the cases reported, upon a descriptive rather than upon an analytical method may induce hesitation in accepting the evidence upon this point.

3. In the case of colored tastes or odors, color may enter the perceptual fusion from experience of the source of taste as colored. The color of the object is an important component of the usual gustatory or olfactory perception. It is easily comprehensible that the odor of violets should be blue in tone, in a given instance; and that, too, without rejecting the synæsthetic element as a sensational part of the perceptual fusion, and interpreting it, instead, as an artificial association. Reduce the intensity of a primary element in a perceptual fusion, and its place may be taken by a normally secondary factor. Thus, we can understand why for *S.* red pepper should taste dull red, and why possibly sweet tastes are black, if, as *S.* is inclined to believe, burnt sugar figured in a vivid experience of childhood. It is, however, difficult to understand how, in colored audition, tonal vision, or gustatory audition, the synæsthetic factor is involved in perceptual experience. In my opinion, we shall not understand synæsthesia until we have made a more thoroughgoing analysis of perception.